Engineering Study Category, Appendix H

Study Topic	Filed Date
Comparisons of Peak Discharges Among Sites with and without Valley Fills for the July 8-9, 2001 Flood in the Headwaters of Clear Fork, Coal River Basin, Mountaintop Coal-Mining Region Southern West Virginia.[Post-2001 WV Flood Analysis]	Report in preparation. Executive Summary included
Comparisons of Storm Response in a Small Unmined and Mountaintop-removal mined Watersheds, 1999-2001, Ballard Fork, West Virginia	Reports in preparation. Executive Summary included
Comparison of Stream Characteristics in Small Gaged, Unmined and Mountaintop-removal Mined Watersheds, Ballard Fork, West Virginia, 1999-2001	Reports in preparation. Executive Summary included
Model Analysis of Potential Downstream Flooding as a Result of Valley Fills and Large Scale Surface Mining Operations in Appalachia	April 2001
Flood Advisory Technical Taskforce Runoff Analyses of Seng, Scrabble, and Sycamore Creeks Hobet Mine Westridge Valley Fill. Feb 2000 Samples Mine Valley Fill #1. Jan 2000 Samples Mine Valley Fill #2. Mar 2001 Samples Mine Valley Fills #1 and #2. Jan 2000 Samples Mine Valley Fills #1 and #2 combined AOC conditions. Nov 2000 Samples Mine Valley Fills #1 and #2 combined Future Forested Conditions. March 2001 Samples Mine Valley Fills #1 AOC conditions. Sept 2000 Samples Mine Valley Fills #1 Future Forested conditions. Feb 2001 Samples Mine Valley Fills #2 Future Forested conditions. Mar 2001 Samples Mine Valley Fills #2 AOC+ conditions. Oct 2000	June 2002
Long-Term Stability of Valley Fills	March 2002
Mining and Reclamation Technology Symposium	June 1999
Estimation of Southwest Virginia Reserve Base of Surface Mineable Coal	July 2000, presented in Chapter III.O
Estimation of Future Mountain-Top Removal Areas in the Eastern Kentucky Region	July 2000, presented in Chapter III.O
Projecting Future Coal Mining in Steep Terrain of West Virginia	April 2000, presented in Chapter III.O

The opinions and views in the studies in this Appendix do not necessarily reflect the position or view of the agencies preparing this EIS. These appendix cover sheets are provided as an aid to the reader to summarize the studies and also do not necessarily reflect the opinions and views of the EIS agencies.

These reports are included in the appendix in black and white. Color versions may be viewed on the following website. http://www.epa.gov/region3/mtntop/index.htm

Comparisons of Peak Discharges Among Sites with and without Valley Fills for the July 8-9, 2001 Flood in the Headwaters of Clear Fork, Coal River Basin, Mountaintop Coal-Mining Region Southern West Virginia. by the United States Geologic Survey

This study was designed to compare peak stream flows generated from mined and un-mined watersheds upstream of summer flooding during 2001. The study was developed to answer, in part, the following:

> *What are the short- and long-term effects of individual mountaintop mining operations and associated valley fills on the following physical, chemical and biological conditions of affected streams and their watersheds, both within the area of direct impact and downstream, and including surface and groundwater. Consider both water quality and quantity, including flooding potential and baseflow. Consider changes on aquatic habitat and stream use.*

Specifically for this study, the interest was in the effect of valley fills on quantity of stream flow resulting from a significant rain storm event. The study determined that peak discharge for a 10-year storm was less downstream from a reclaimed valley fill than downstream of an area without a valley fill. However, the peak discharge for a 25-year storm was greater from two sites with valley fills than two sites without valley fills. Peak discharge downstream from an unreclaimed valley fill was greater than at a reclaimed valley fill.

The limitations of the study are the inherent difficulties of reconstructing the cause-and-effect of results from a storm event based on watershed condition observations and measured high water marks. Only a small number of sites were evaluated, and increased or decreased peaks are attributable to site-specific factors for each watershed. Thus, it is difficult to generalize mining impacts on runoff as a "one-size-fits-all" finding. Also, due to site conditions, increases in peak runoff may not cause or contribute to flooding. Flooding results when stream banks overflow and cause hazards to persons or damage to property, roads, etc (i.e., increased peaks contained within a stream channel would not be considered flooding).

Comparisons of Storm Hydrographs in a Small Valley Filled and Unmined Watershed, 1999-2001, Ballard Fork, West Virginia by the United States Geologic Survey

The study was designed to compare stream flow characteristics in similar sized watersheds with and without a valley fill. The study was designed to answer, in part, the same questions reported in the previous study. Specifically for this study, the committee was interested in the effect of valley fills on quantity of stream flow downstream following a significant rainfall event. The study found that runoff from mined watersheds exceeded runoff from unmined watersheds when rainfall exceeded

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1.0 inch per hour. The study also found that valley fills tend to store a considerable amount of water and release the water more slowly than watersheds without fills.

The limitations of the study are the small number of sites that were evaluated and the difficulty in monitoring for the appropriate period when a major storm event occurs. Despite the occurrence of flooding in southern West Virginia in 2000 and 2001, the sites monitored did not include a major rainfall event. As stated above, increased or decreased peaks are attributable to site-specific factors in the contributing watershed. Thus, it is difficult to generalize mining impacts on runoff from a limited number of sites. It is important to note that increases in peak runoff may not cause or contribute to flooding (i.e., increased peaks contained within a stream channel would not be considered flooding).

Model Analysis of Potential Downstream Flooding as a Result of Valley Fills and Large Scale Surface Mining Operations in Appalachia by U.S. Army Corps of Engineers Pittsburgh District

The purpose of this study was to evaluate the potential for flooding as a result of the construction of valley fills and the related hydrologic modifications to terrain associated with mountaintop mining. This study was based on computer modeling simulations, which looked at the impacts of rainfall events on three individual valley fills, as well as the cumulative impacts of two fills on a downstream area. The study was designed to answer questions described in the initial study, above.

To summarize, the study found that storm runoff models calculated higher post-mining peak flows than pre-mining peak flows for the same design storms. Model results concluded that peak runoff during mining at one site was also higher than pre-mining flows. The study also reported that the type of ground cover (e.g., trees versus, grass/legumes) and reclaimed topography (e.g., AOC v. non-AOC) influenced post-mining peak runoff. However, none of the predicted increases in peak flow caused flooding outside the downstream channel.

The limitations of the study are the small number of sites modeled as well as the difficulty of modeling during-mining conditions. As previously mentioned, increased or decreased peaks are attributable to site-specific factors in the contributing watershed. Thus it is difficult to generalize mining impacts on runoff.

Flood Advisory Technical Taskforce Runoff Analyses of Seng, Scrabble, and Sycamore Creeks by West Virginia

The studies were designed to determine whether mining caused increases in "peak flow" downstream from the mine sites and if so, the extent to which peak flows were increased. It should be noted that the West Virginia study also evaluated the impacts of logging on peak flows. In general, the study concluded that mining does influence the degree of runoff, but that the extent to which a change in runoff may have actually caused or contributed to flooding were site-specific. Site-specific factors may include topographic influences, stream channel conditions, distance downstream from the mine site, man-made channel restrictions, etc.

The study recognized the need for the proper, thorough analysis of peak flow and flooding potential. West Virginia is evaluating their study conclusions and recommendations and considering regulations that would require peak flow analysis and other measures to minimize flooding potential downstream of mine sites and logging operations.

Long-Term Stability of Valley Fills by OSM

This study was designed to address fill stability concerns indicating a perception that potential instability of valley fills would have consequences similar to impoundment structure failure. Scoping concerns also suggested that massive valley fills upstream of populated areas present safety hazards to life and property.

The study design was to evaluate the following questions:

> *Are fills adequately stable under the current regulatory scheme? If not, why and what alternatives are available?*

The study found that valley fill instability (i.e., landslides or land slips on fills) is neither commonplace nor widespread. The study concludes that valley fills, when constructed as designed (i.e., in conformance with the regulatory design and performance standards), are stable structures. Only twenty cases of critical instability (occurring over a large fraction of the fill face and/or requiring a major remediation effort) occurred out of more than 4,000 fills constructed in the past eighteen years.

One limitation of the study is that it relied on reports of known fill instability. No site-specific drilling, testing or analysis of active or completed fills could be performed due to the difficulty and expense of drilling large rock fills, obtaining adequate samples, and performing representative testing. The evaluation of 128 pre-selected fills in four states may not be considered as an appropriately large or representative sample. Other criticisms could include claims that the existing valley fills may not have achieved final consolidation and established a stable phreatic level. As such, the study cannot guarantee against future failures.

Estimation of Southwest Virginia Reserve Base of Surface Mineable Coal by Erik Westman, Department of Mining and Mineral Engineering, Virginia Polytechnic and State University (VPI)

The project was designed to identify areas of potential future surface mining. Remaining resources for Virginia coal seams historically surface mined are delineated using geographic information system (GIS) methods. Specifically, the study was developed to illustrate:

What are projections for the extent of mountaintop mining in the Appalachian coalfields in the future?

In addition to delineating the remaining coal extent in seams historically surface mined in Virginia, VPI applied GIS techniques assuming "stripping ratio" (15:1), minimum tonnage (greater than 500,000 ton reserve blocks), and minimum coal thickness (18 inches) to each of the five seams. This approach was designed to show potential surface-mineable coal reserve areas based on typical current mining engineering thresholds for viability. However, it is extremely difficult to apply generalized mining engineering assumptions using a GIS model with great confidence. Therefore, the study presents only the projected geologic extent of coal that has not been mined in seams that have historically been mined by surface mining methods in Virginia. This map displays areas where mining exists, but mining may not be feasible, as discussed below:

– Available digital information on past mining is not exhaustive, but is based on the best available comprehensive data. Coal mining in these areas has occurred for more than 100 years and accurate records of all past mining is not possible to portray. Therefore, the maps indicate areas of remaining coal that may have actually been mined.

– A viable mining operation must be capable of efficiently removing a certain volume of overburden relative to each ton of coal extracted (the amount of overburden to coal is termed the "stripping ratio). Therefore, if the coal seam is too thin or too deep in the mountain (i.e., overlain by an amount of overburden than is more expensive to remove than the value of the coal recovered), surface mining may not be feasible. The GIS maps show the possible presence of coal, but do not take into account if the coal thickness and stripping ratio is suited for surface mining. Thus, the maps show a much larger area than will ever actually be mined.

– Currently the *average* stripping ratio is about 15 cubic yards of overburden to one ton of coal. However, the actual stripping ratio for any reserve block is dependent on the type and size of equipment to be used. Some companies may be able to mine areas with ratios as high as 25:1. Also, if a company has certain types of equipment, e.g., trucks, loaders and augers or highwall miners, they may tend to mine a reserve block differently than a company that has trucks and shovels or a dragline.. Because these are very company and site-specific decisions, they can not be easily generalized and modeling by GIS can not always provide credible or reliable results.

– Coal quality is an extremely important factor in mining viability. Mining companies must provide "compliance" coal to meet contracts for electrical generation (to maintain air quality standards) and must attain certain specifications for coking and steel production. Coal quality can be widely variable--even within the same seam over short distances. Thus, some areas of coal shown on the maps may not be mineable due to coal quality, and the GIS process in this study was unable to account for coal quality issues.

- A surface mine must encompass a coal reserve block of sufficient size to be viable. Therefore some areas shown on the GIS map, after subtracting out poor quality and thin coal and excessive overburden, may not represent enough coal to warrant undertaking a mining operation. A GIS can determine the volume of coal in any given reserve polygon. But, the ability to graphically represent this factor, considering the other issues discussed here, does not overcome the study limitations to represent precise future mining locations.

- Mineral and surface ownership are another crucial factor relevant to surface mining feasibility. Even though there may be a coal reserve block of sufficient size to present viable mining potential, if the mineral ownership is split and rights to mine can not be obtained from all the mineral holders, mining can not occur. Similarly, in some circumstances, failure to obtain surface owner permission to mine will hinder mining. Other surface protected areas (e.g., state and national parks, forests, lakes, rivers, cities, hospitals, highways, etc.) may limit mineability. The costs of dealing with the presence of homes, buildings, gas wells, utility lines, and other features could preclude mining. A GIS can consider some, but not all, of these factors. Thus the GIS maps portray areas which might otherwise be deleted in site-specific analysis.

- Other site-specific factors like environmental constraints may keenly influence decisions to mine. For example, in Virginia, the large amount of past mining presents challenges to future mining. The presence of acid-forming materials in the overburden or pre-existing environmental liabilities (acid mine drainage, hazardous or industrial waste sites, highwalls, coal waste embankments or impoundments, etc.) may make mining costs excessive and limit mining particular reserves. A GIS can not model these factors.

In summary, the maps shown in this EIS identify only very general locations where potential future mining might take place, based on the geologic extent of remaining coal. This illustration is not meant to represent that this constitutes the actual scope of future impacts to the environment in the EIS study area. The actual future mining areas will be somewhere within these areas, but are dependent on complicated interplays of site-specific ownership, existing uses, mining engineering, environmental, and business/economic considerations. The study approach and findings are presented in III.O of the EIS. Due to the GIS nature of the study, a report is not presented in this appendix.

Estimation of Future Mountain-Top Removal Areas in the Eastern Kentucky Region by the Kentucky Geological Survey (KGS)

The project was developed to identify areas of potential future surface mining by delineating remaining areas of coal resources in three historically surface-mined coal zones in eastern

Kentucky (namely the Richardson, Broas, and Peach Orchard coal zones). The study design was to answer the same questions as described in the Virginia discussion, above.

The GIS data base was provided following the specified procedure to map the geologic extent of coal in the three zones, eliminate known areas of past mining, and represent the remaining coal resource on GIS maps. Like Virginia, KGS attempted to delineate the mineable reserves by applying the mining engineering criteria used in mine planning. However, the same limitations described above for the Virginia study are applicable to Kentucky. For this reason, the EIS only presents the geologic extent of remaining coal, and the reader should not construe that the map illustrates the actual extent of future mining impacts in Kentucky. The study approach and findings are presented in III.O of the EIS. Due to the GIS nature of the study, a report is not presented in this appendix.

Projecting Future Coal Mining in Steep Terrain of Appalachia by the West Virginia Geological and Economic Survey (WVGES)

The project was assimilated into the EIS as a means to identify areas of potential future mountaintop surface coal mining in West Virginia. WVGES delineated potential future mountaintop mining areas by identifying remaining coal resources of the Coalburg zone, Stockton coal seam and overlying riders, and “Block” coal zones (No. 5 Block, No. 6 Block, and No.7 Block). The objective for this study was the same as for Virginia and Kentucky (see Virginia study description, above).

The GIS data base was provided following the specified procedures. Unlike Virginia, WVGES applied no mining engineering considerations to the data layers as part of this study. The EIS only presents the geologic extent of remaining coal. For the same reasons, as discussed above for the Virginia study, the WVGES study only portrays best available information on remaining coal in historically surface-mined seams. The reader should not construe that the map illustrates the actual extent of future mining impacts in West Virginia. The study approach and findings are presented in Chapter III.O. of the EIS. Due to the GIS nature of the study, a report is not presented in this appendix.